Plume-Lithosphere Involution: What Can We Infer About the Interior from the Gravity and Dynamic Topography?

S E Smrekar (Jet Propulsion Laboratory, MS I M-501, Pasadena, CA 91109; tel. 818-354-4192, ssmrekar@cythera.jpl.nasa.gov)

For Venus there is an ongoing debate about the thickness of the lithosphere and the vigor of mantle convection. Numerous studies have shown that either thinning of a very thick (~300 km) thermal lithosphere or an active plum beneath an Earth-like (~100 km) thermal lithosphere can match the gravity and topography signature of hotspot-like features. A model of the plume-lithosphere evolution, which includes temperature-dependent viscosity within the lower lithosphere and plum head, indicates that a variety of factors make a unique interpretation of the lithospheric and plume properties very difficult:

1) The gravity and topography signature of a plume evolves over the lifetime of the plume; the apparent depth of compensation seldom corresponds to the center of the plume head.

2) The gravity-topography admittance due to the plume can produce a signature similar to that of top-loading due to a volcano, without producing short wavelength topography.

3) A layer of depleted mantle beneath the thermal lithosphere can act to either reduce or increase the apparent dynamic topography, depending on the viscosity/density structure, which evolves with time.

For terrestrial hotspots, there are both more independent constraints from seismology, heat flow, and geochemistry, and more complications in the form of a low-viscosity zone and plate motion. The non-uniqueness of lithosphere and plume parameters in models of gravity and dynamic topography for both Venus and Earth can be reduced by estimating the expected amount of volcanic loading, residuum, the elastic thickness, and the evolutionary stage of the hotspot.